CORNING GLASS WORKS

ELECTRO-OPTICS LABORATORY

RALEIGH, NORTH CAROLINA

IMPROVED SCREEN FOR REAR PROJECTION VIEWERS

Technical Report No. - 9

Date - April 4, 1966

Period Covered - March 8, 1966
to
April 4, 1966

STATT

Technical Report #9

I. <u>Theoretical Investigations</u> (Mie Scattering)

Theoretical investigations of light scattering by
particles with sizes comparable with the wavelength
of illumination was concluded. Additional light
scattering functions have been computed for M = .8,
1.30, and infinite, for particle sizes from α = 1, to
10 in increments of 1. We have also computed add-
itional scattering functions for M = .9, 1.05 and
1.20 for values of α from 6 to 10 in increments of 1.
Here α is the ratio of the scattering particles
circumference to the wavelength of illumination,
$\alpha = \pi D/\lambda$; and M is the relative index of refraction
between the particle and the surrounding medium. An
infinite refractive index implies metallic particles.
<u>The data has been summarized in gain vs. angle curves
showing the scattering functions.</u> Additional data
processing of this data has corrected it for broading
of the angular gain curves by refraction at the air
glass interface and the trapping of light by total
internal reflection. <u>The new data have also been
summarized to show the gain at θ = 0 vs. particle size,
efficiency vs. gain and α.</u> We have also considered
factors such as change of scattering coefficient with
particle size and wavelength, which determine the
color fidelity of a material.

The experimental work of phase III will utilize the
results from these theoretical studies to direct
specific materials investigations. In this regard we
will specify parameters such as the relative index of
refraction between the particles and the surrounding
glass, the size and distribution of sizes of particles,
their number density and the thickness of the samples.

-2-

These will be translated into glass compositions and,
if necessary, subsequent heat treatments by the in-
dividual materials groups. Materials of primary
interest are; a, the glass-ceramics; b, Fotoform and
Fotoceram; and c, the sintered glasses. The particles
of initial interest have sizes which lie between .3
and 1.0 micron and a refractive index between the
particle and surrounding glass of .8, 1.20 and 1.30,
i. e., as far from unity as possible using glasses but
without using metallic particles. We are also con-
cerned with limiting the range of particle sizes as
particles which are too small produce undesirable Ray-
leigh scattering and particles which are too large
produce a screen with hot spots because of too little
light scattering. Number density will be chosen to
produce sufficient scattering from thin samples, i. e.,
not more than 2 millimeters thick. This is required
if these screens are to have sufficient resolution between
10 and 20 line pairs/mm. The results of these first
materials investigations will then be used to direct
further materials studies.

We have also investigated the feasibility of approxi-
mating the angular gain curves with an empherical
equation. The preliminary results of this indicate that
over the viewing angles of interest it is possible to
use an equation of the form

$$\text{gain }(\theta) = (A\alpha + B)e^{-K\theta^2}$$

with the curve fit being good to at least the half
power point, and less than 10% error out to 3 times the
angle at half power. This approach is particularly
useful when computing the scattering function for a
distribution of particle sizes. This will also be
treated in detail in the final report of phase II.

A. Other Materials and Approaches

1. A louvered screen discussed in previous
    technical reports and patented by A. H. J.
    De Lassus St. Genies[1-3] has been constructed.
    The screen was made by placing 13 - ¼" plates
    measuring 1" x 4" together as shown in
    Figure 1. A hole was drilled down each side
    and bolts were then inserted and tightened,
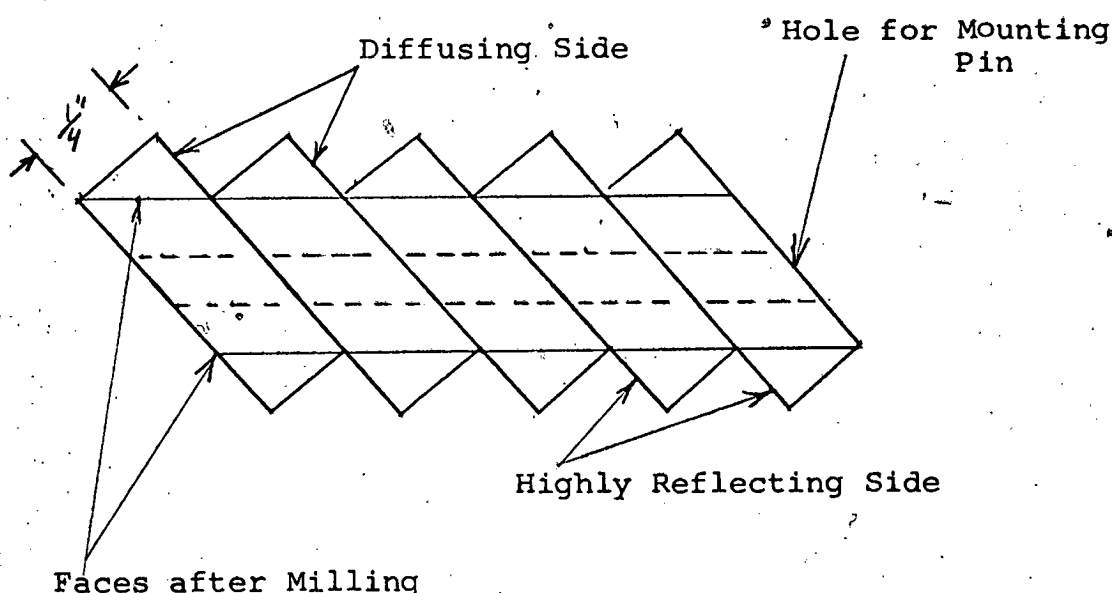   holding the blocks firmly together.

Diffusing Side   Hole for Mounting
                                              Pin

Highly Reflecting Side

Faces after Milling

Figure 1

Construction of the Louvered Screen

The top and bottom of the stack was then
machined flat to a .35" overall thickness.
The two faces were then sanded and polished.
Each block was then numbered and the stack
disassembled. One inside face of each block
was sanded so when aluminized it would be
diffusely reflecting. Both faces were
aluminized and the stack reassembled. The

resulting screen has a usable area measuring
3 - 3/4" x 3 - 3/8". An analysis of this
model will be made next period to determine
what major optical problem exist when viewing
this type of screen and also some of the
technologies which may be of value in
building practical samples.

2. Ultraviolet Sensitive Screen

There are many applications where only black
and white material is to be viewed such as
microfilm, maps, line drawings, and etc. For
these applications it may be useful to use
near ultraviolet illumination and a fluorescent
screen. These screens could be coated on the
projector side to pass the ultraviolet portion
of the spectrum and reflect most of the
visible light from the projector. A second
coating under this would absorb the residual
visible from the projector and the ambient
light from the viewing area. A mixture of
phosphors would give a white background with
black lines as opposed to a blue or green back-
ground which is objectional.

Two 6" x 6" samples of a fluorescent type of
glass without any coatings have been obtained.
Preliminary evaluation will begin next period.

II. Instrumentation

A. Goniophotometer
The goniophotometer is being put through final testing
and will be ready for use within two weeks.

B. Modulation Transfer Function Analyzer
The delivery of components for this is about 70% com-
plete. Already certain parts of the system are to-

gether and completion is expected near May 1, 1966.
The first use of the system will be in making the
sine-wave resolution pattern. After this is com-
pleted these masks will be used for measuring the
resolution properties of samples of rear view screen
materials.

References

[   ] "Improved Screen for Rear Projection
Viewers," Technical Report No. 4, November 5, 1965.

STAT

[   ] "Improved Screen for Rear Projection
Viewers," Technical Report No. 8, March 8, 1966.

STAT

3 A. H. J. De Lassus St. Genies, Projection Screen with
Reflex Light-Transmission, U. S. Patent No. 2,931,269,
April 5, 1960.